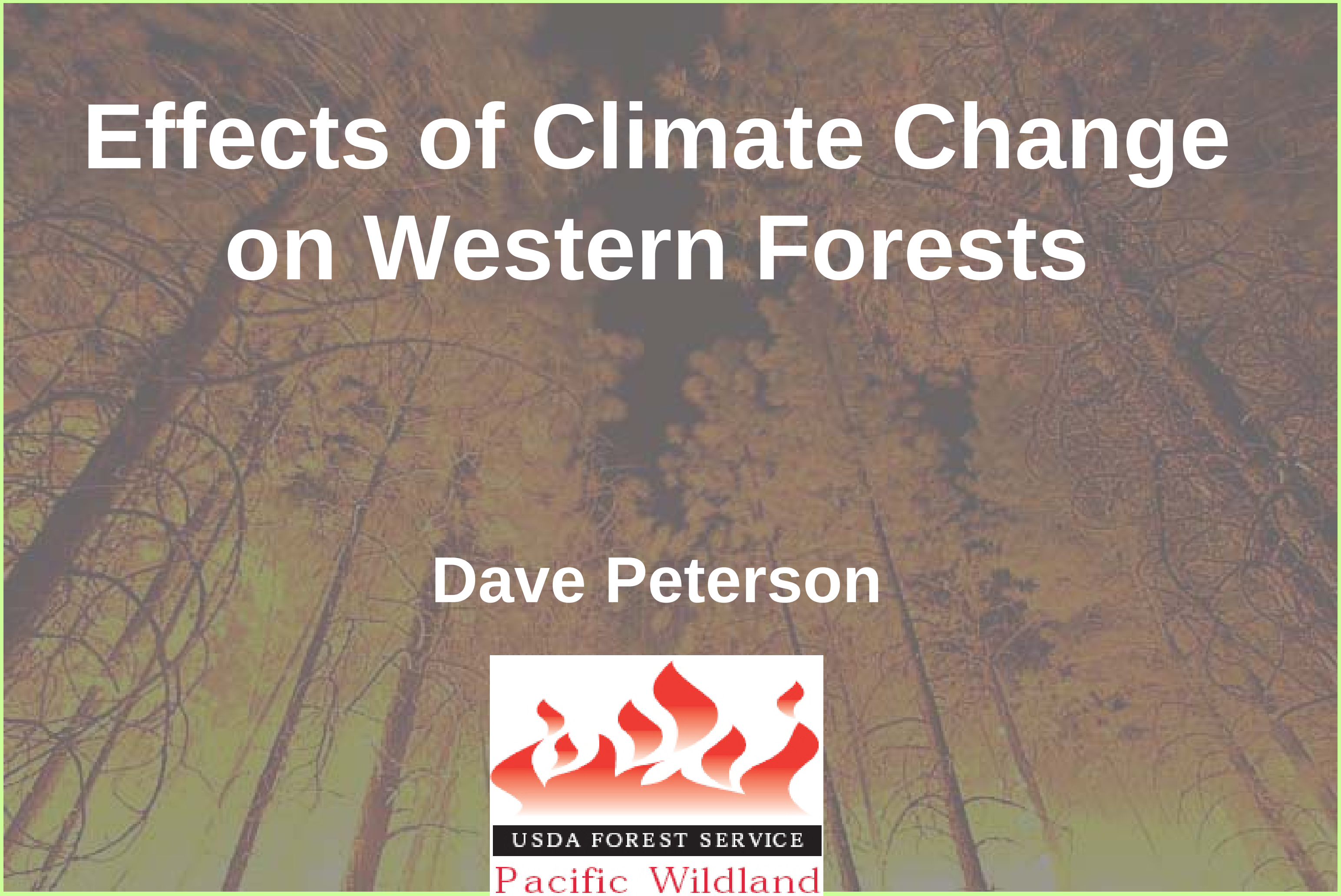

Effects of Climate Change on Western Forests

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Pacific Wildland Fire Sciences Lab
SEATTLE, WASHINGTON

Climate Change Impacts on Natural Resource Management in the Columbia Basin
June 24, 2008

What can we learn from the past?

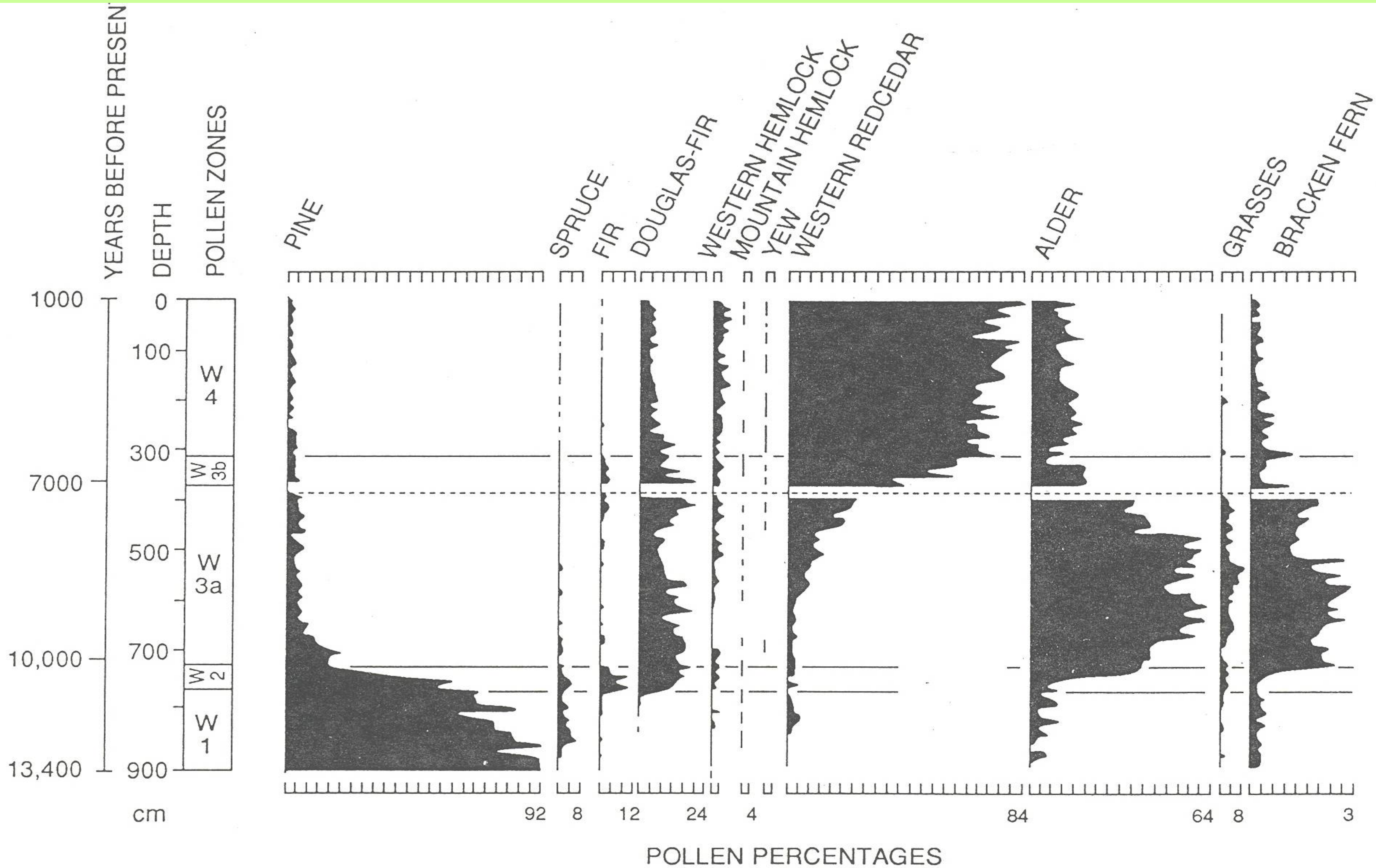
Climate is always changing

Abundance and distribution of tree species changes individually in response to climatic variability

Are warm periods of the past an analog for the future?

- 9000 – 5000 years BP
- 900 – 700 years BP

Forest vegetation varies over time



Pollen record in sediment core from Lake Washington, Washington State

Climate change and tree regeneration

Key to regeneration is effects on limiting factors

- Snowpack
- Length of growing season
- Soil moisture in summer

Effects of a warmer climate will be site specific – precipitation patterns critical

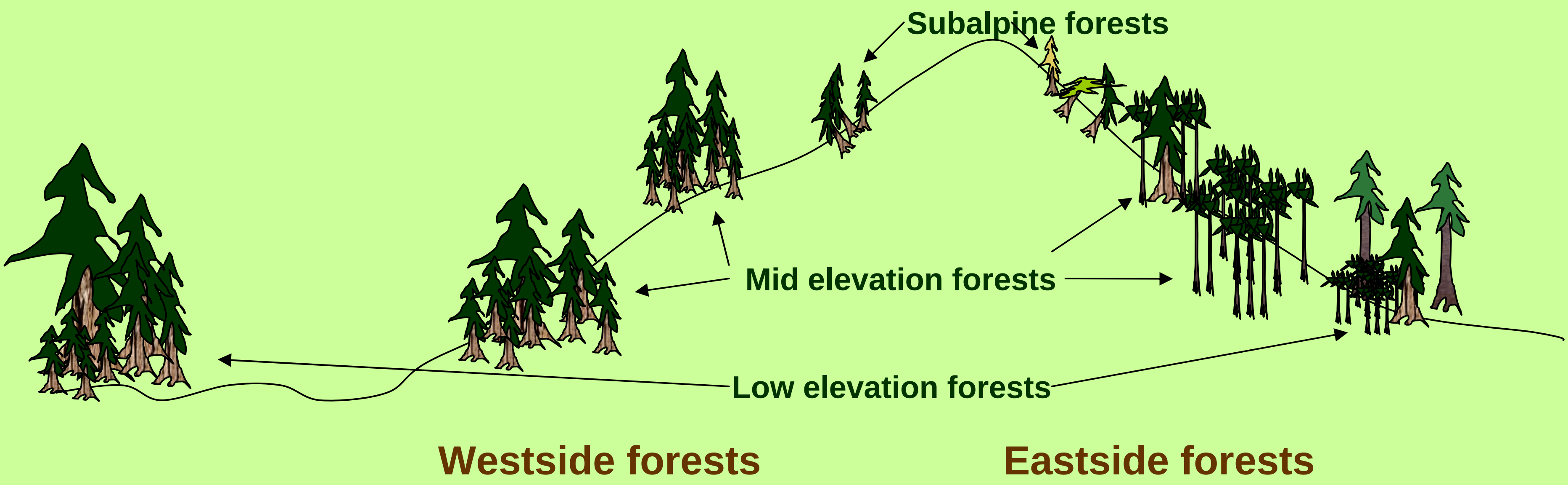
- *In high-snow forests*, regeneration will increase
- *In high-rain forests*, regeneration may increase
- *In dry forests*, regeneration will decrease

Climate change and tree growth

Subalpine forests: Less snowpack; longer, warmer growing seasons = **Growth increase**

Mid elevation forests: Warmer summers, less snow pack = **Depends on precipitation**

Low elevation forests: Warmer summers, less snow pack = **Large growth decrease**



“If there is one word that describes the West, it is **aridity**.”

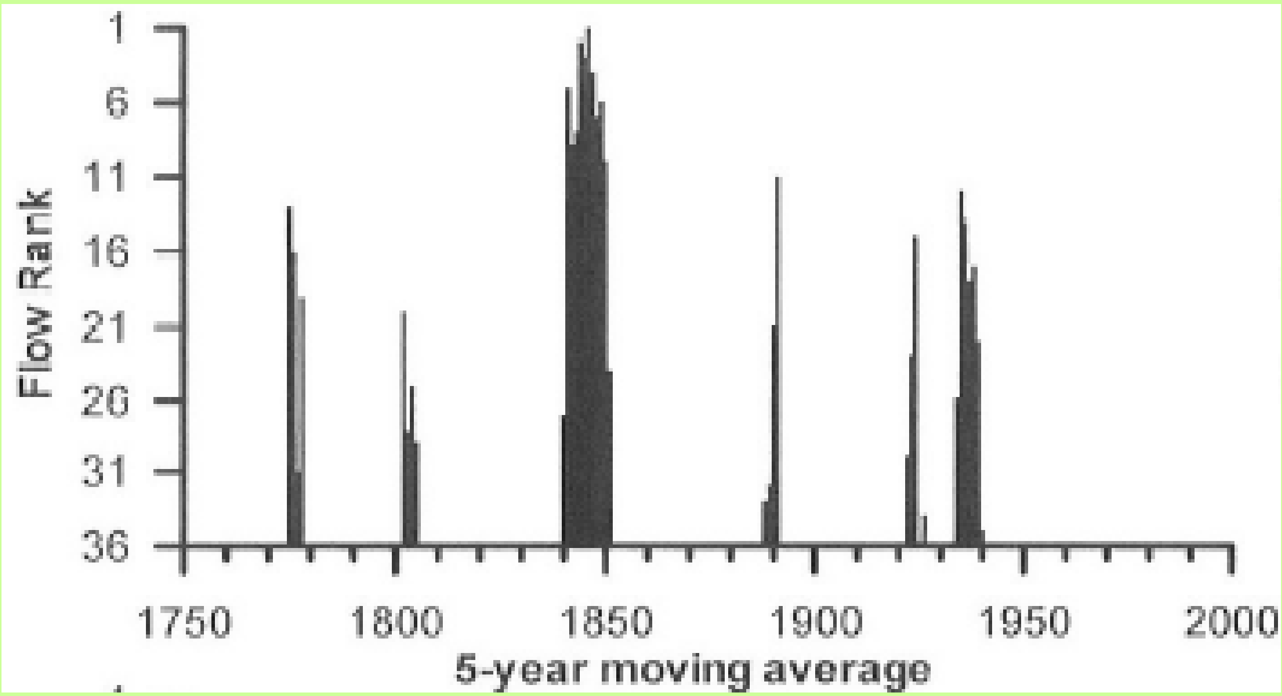
Wallace Stegner

Where the Bluebird Sings to the Lemonade Springs

Dying pinyon pine **Jemez Mts., October 2002**

Jemez Mts., May 2004

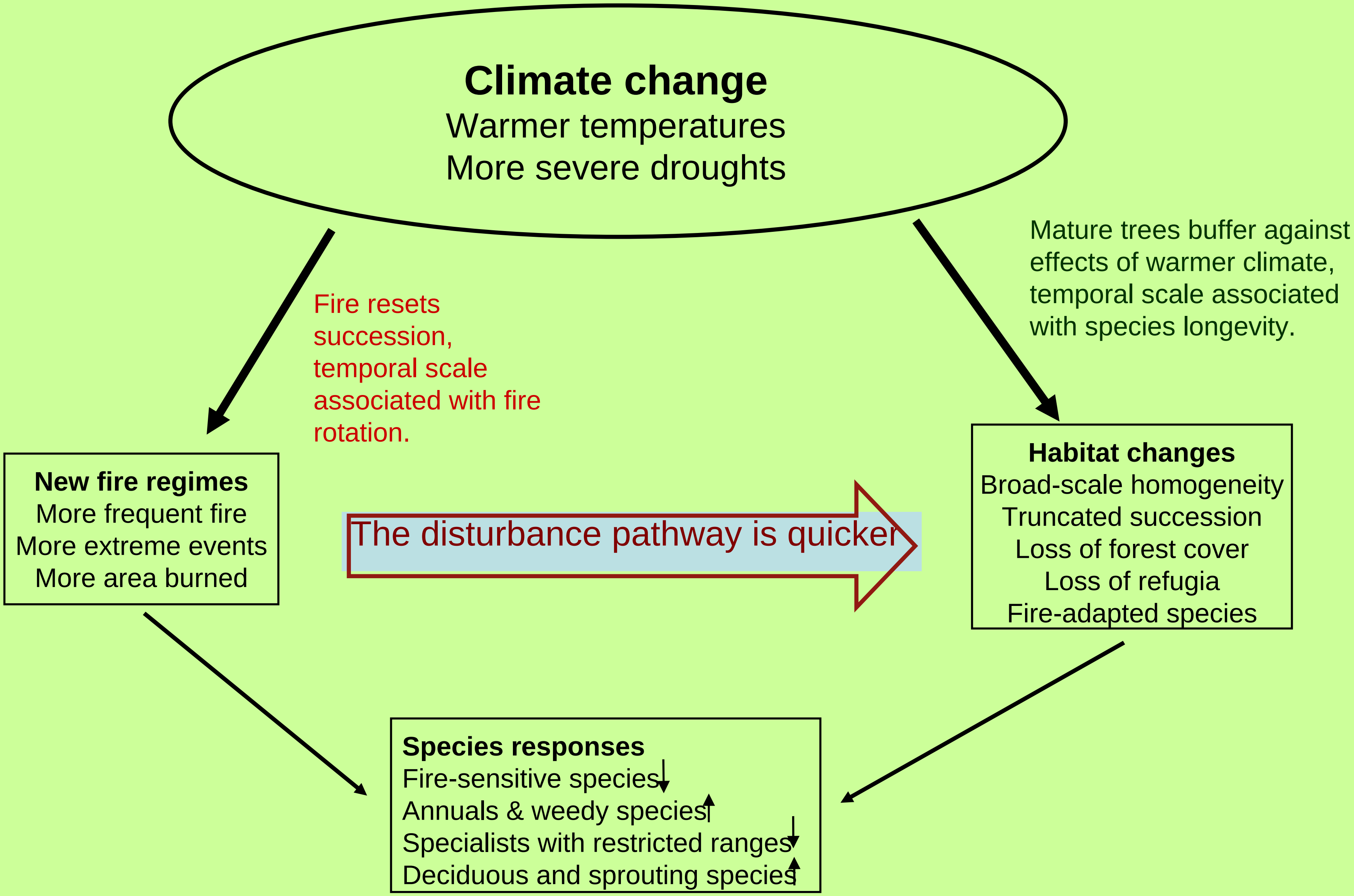
Droughts were more common prior to 1950



Gedalof et al. (2004)

Streamflow for the Columbia River, reconstructed from tree-ring data

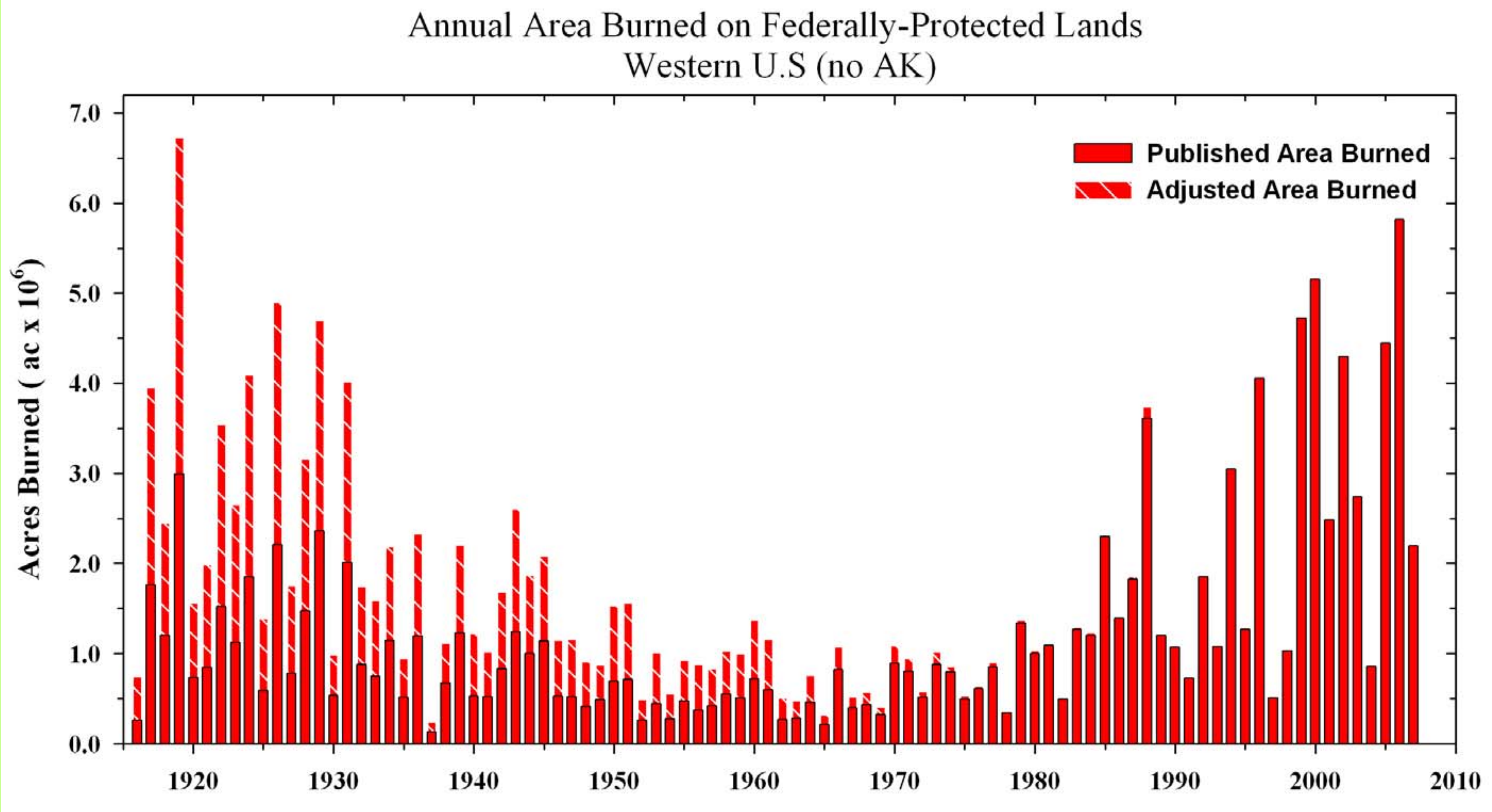
Disturbance drives ecosystem changes



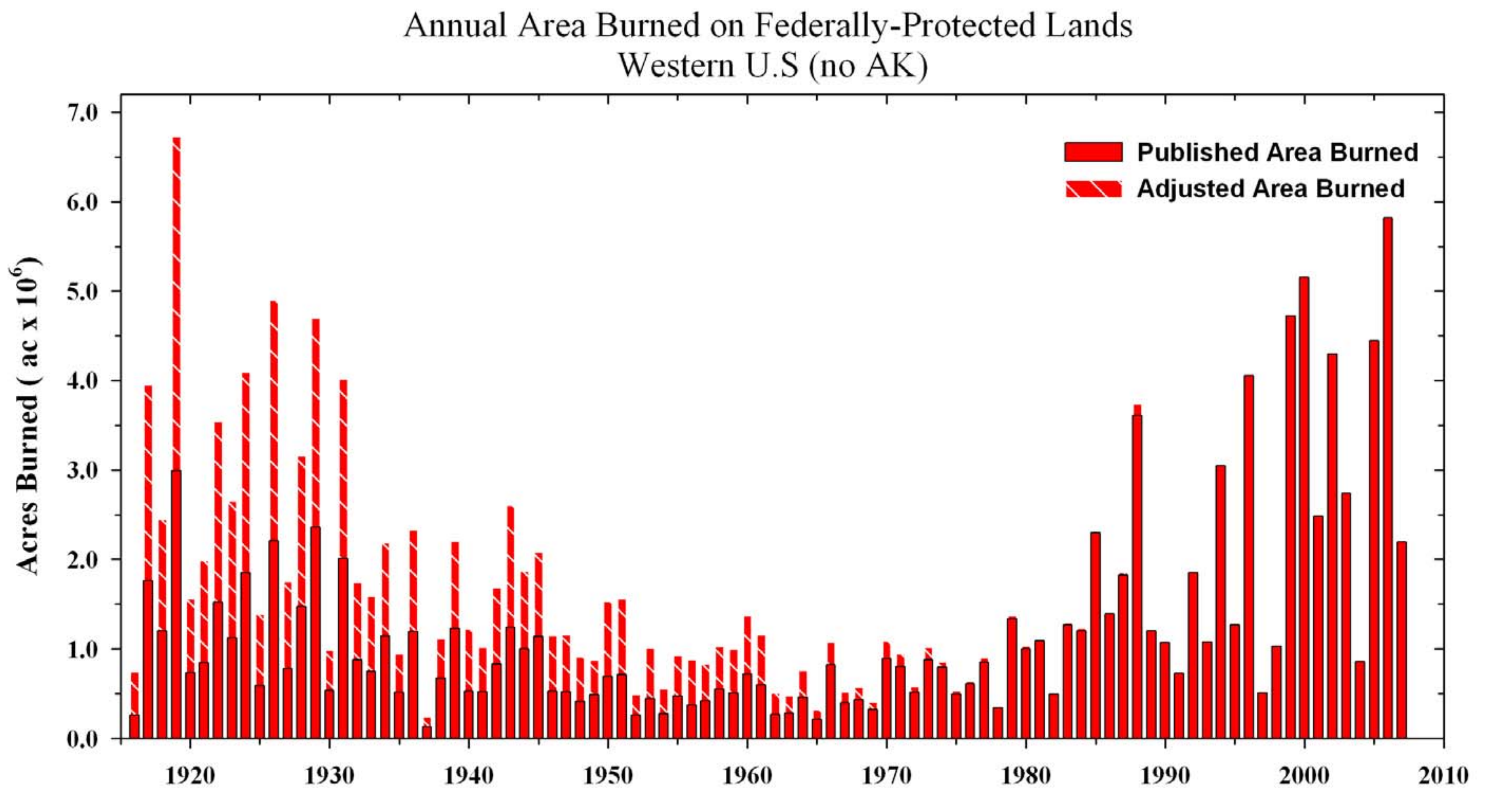
What causes large and severe fires?


WEEKLY WORLD
NEWS
August 1, 1994
75 cents
Tourist took this photo just hours before raging Washington inferno!
UFO SPARKED WASHINGTON FOREST FIRES!
Rat Creek Fire explodes across the forest!

Area burned – Western U.S., 1916 - 2007

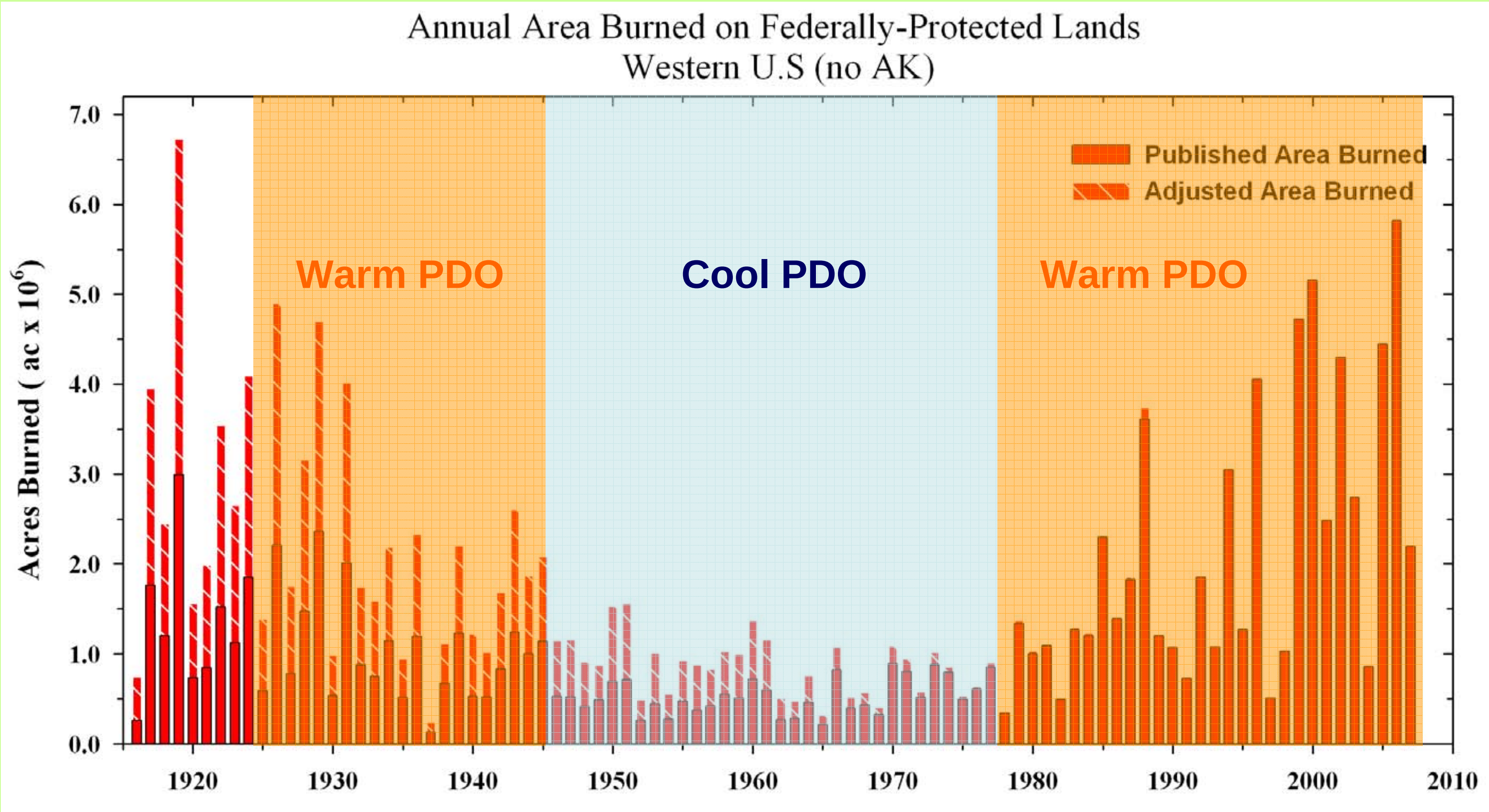


Area burned – Western U.S., 1916 - 2007



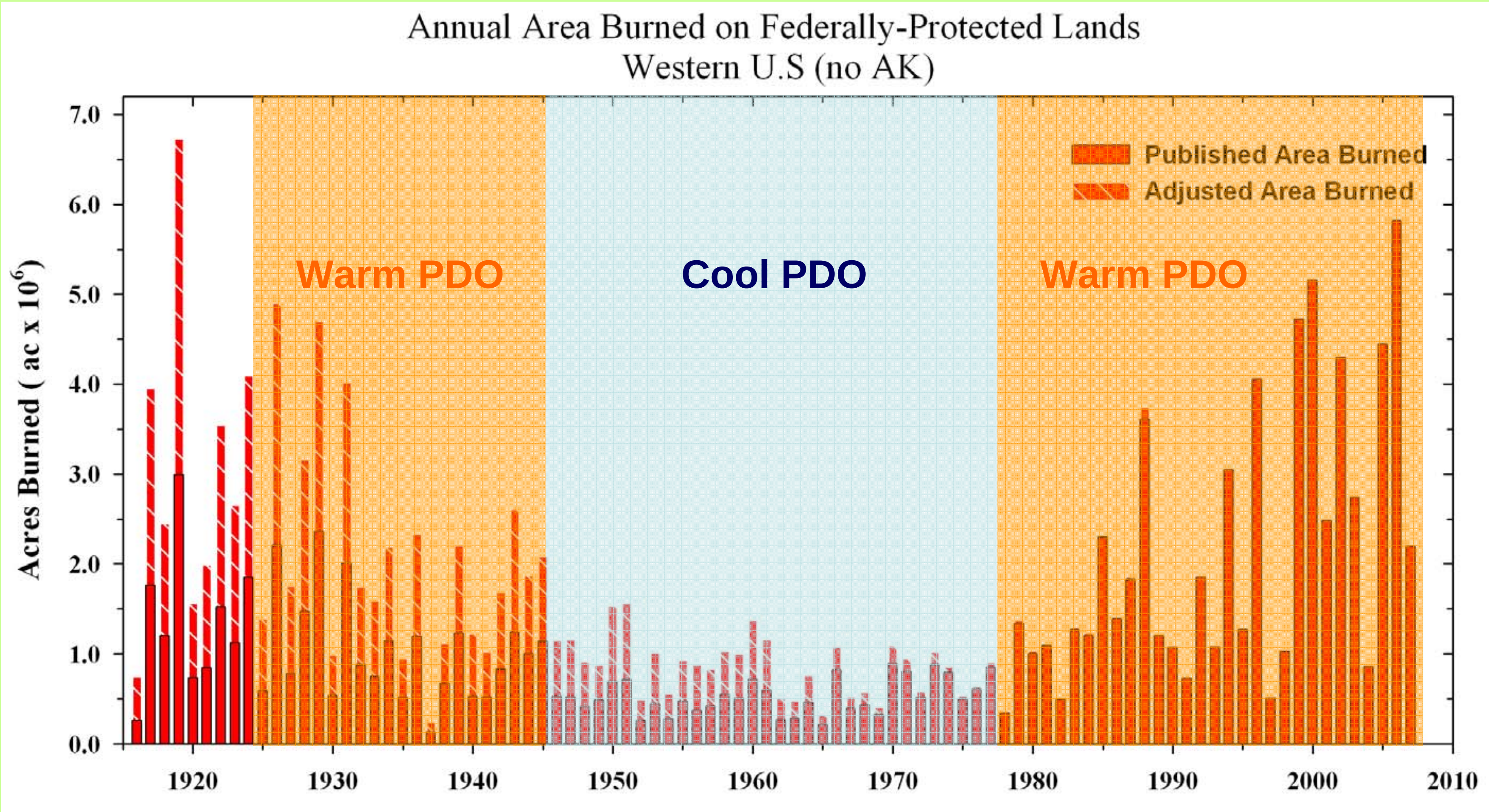
Fire suppression → Fire exclusion → Fuel accumulation

Area burned – Western U.S., 1916 - 2007



Fire suppression → Fire exclusion → Fuel accumulation

Area burned – Western U.S., 1916 - 2007



Fire suppression → Fire exclusion → Fuel accumulation

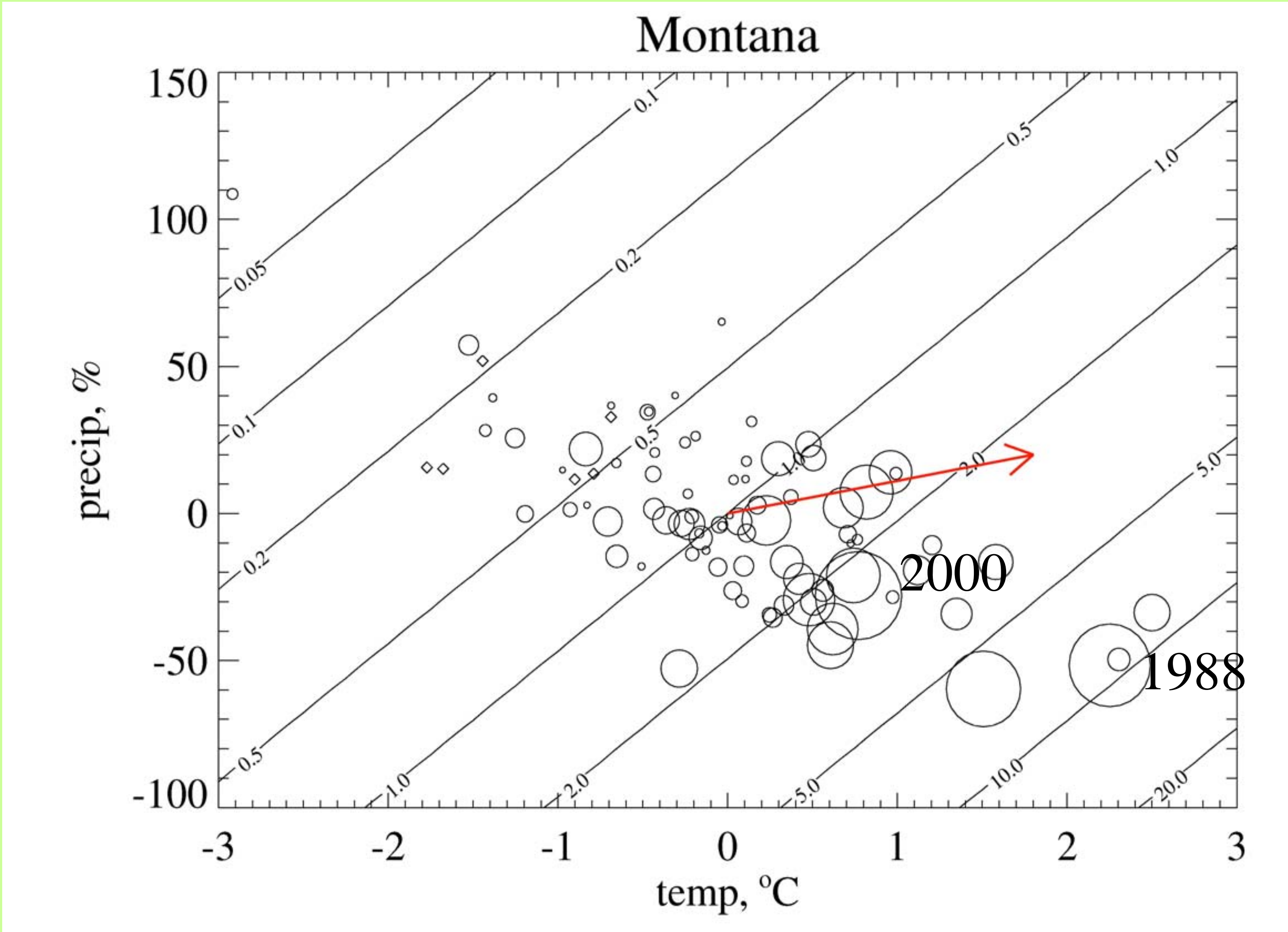
Lots of fire → Much less fire → Lots of fire

Years with fire area > 200,000 acres

	Warm-phase PDO	Cool-phase PDO
Idaho	15	7
Oregon	14	5
Washington	11	2
TOTAL	**40 (74%)**	**14 (26%)**

National Forest data, 1916-2007

Wildfire area burned – *2°C increase*



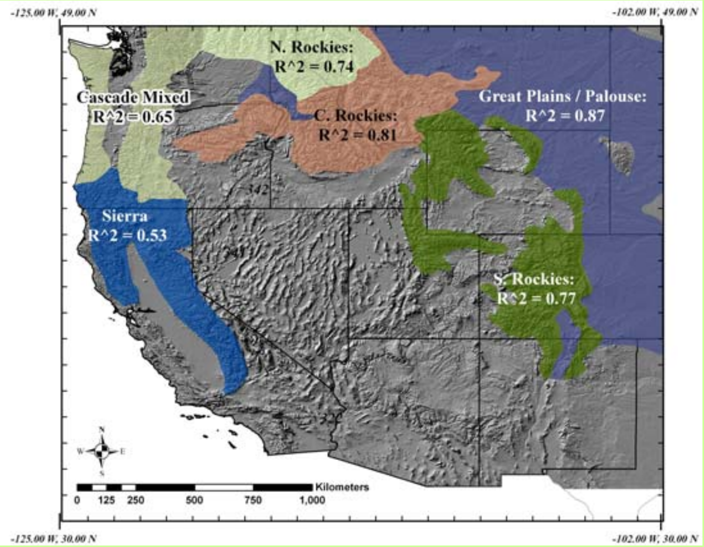
Future wildfire?

Analysis of wildfire data since 1916 for the 11 contiguous Western states shows that *for a 2^{o}C increase* that *annual area burned will be 2-3 times higher*.

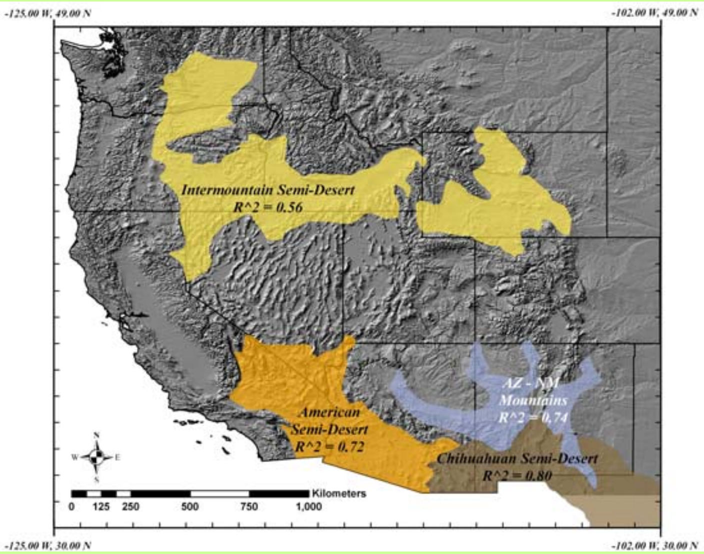
McKenzie et al. (2004), *Conservation Biology* 18:890-902

Climate, vegetation, and fuels

Fuel moisture (associated with current-year climate) drives extent and severity of fire



Fuel abundance and continuity (associated with previous-winter climate) drive extent and severity of fire

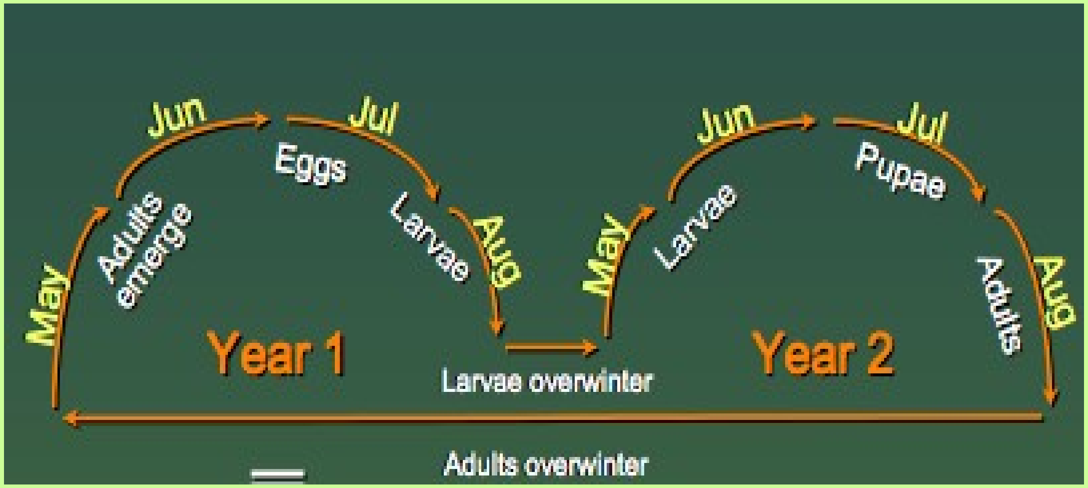



Dendroctonus ponderosae Hopkin

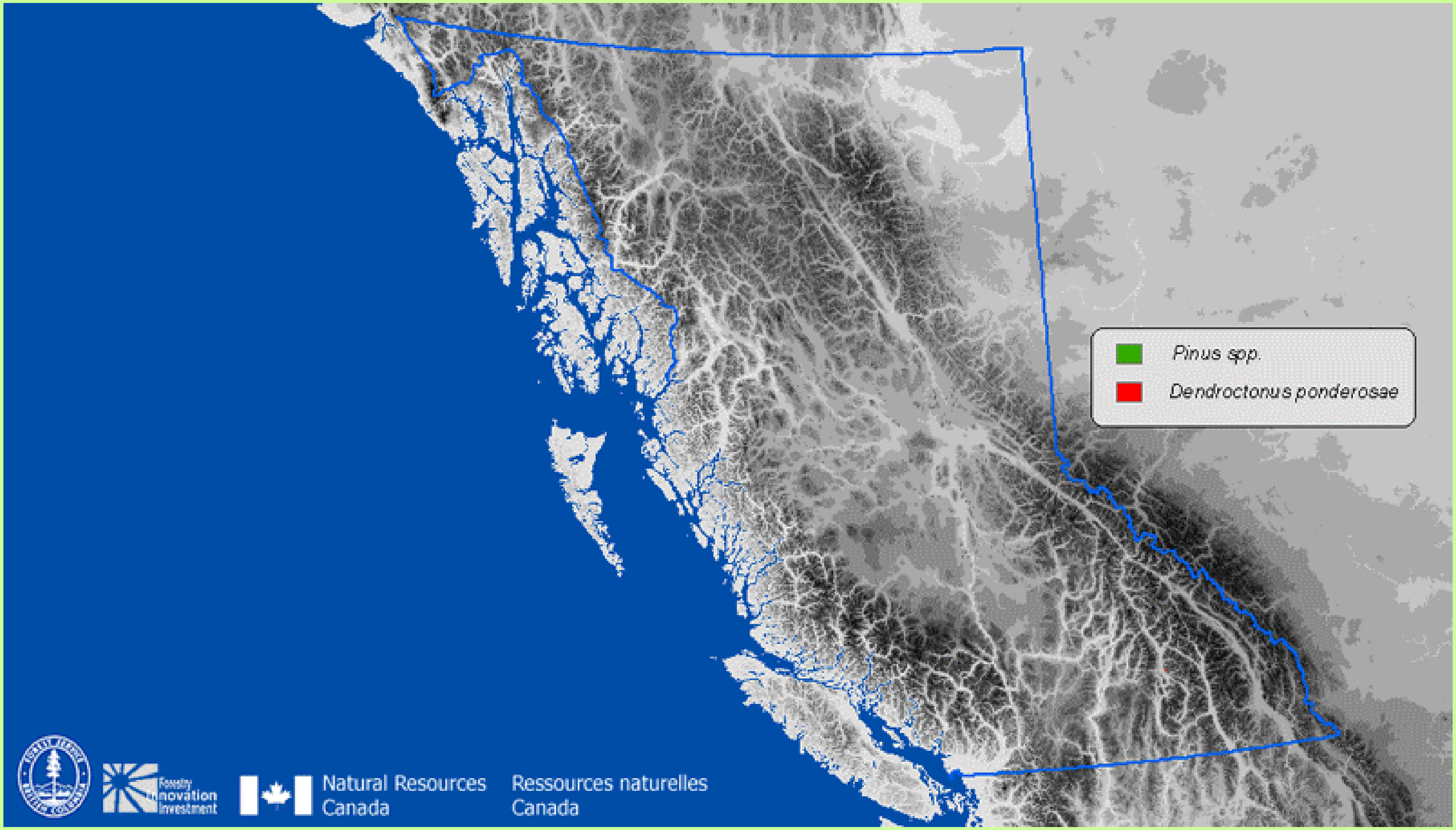
Effects of temperature increase on mountain pine beetle

- Population synchronized by temperature (onset of spring)

- Rate of generation turnover increases with temperature increase

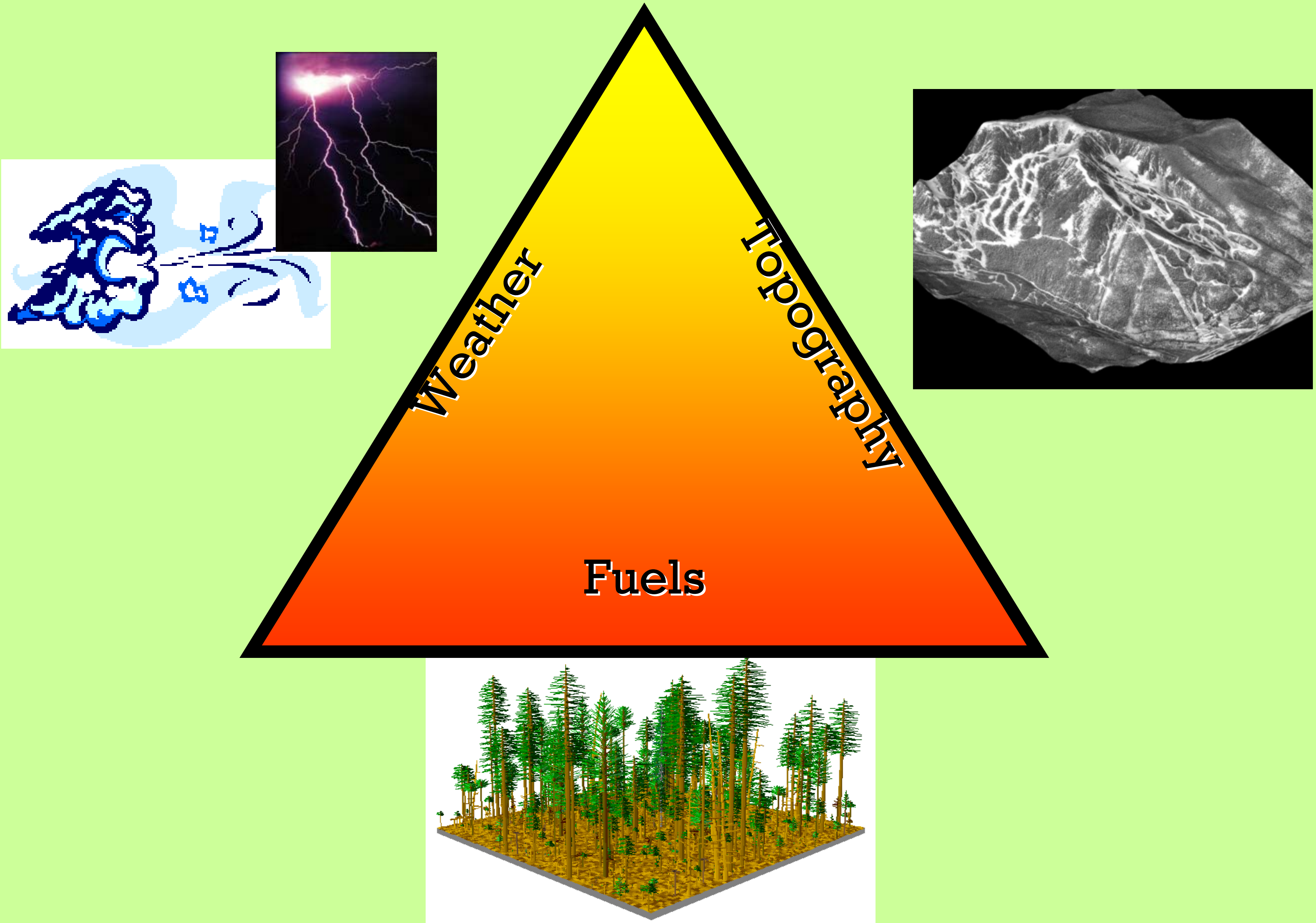


Mountain Pine Beetle outbreaks (1959-2002)



Courtesy of Mike Bradley, Canfor Corporation

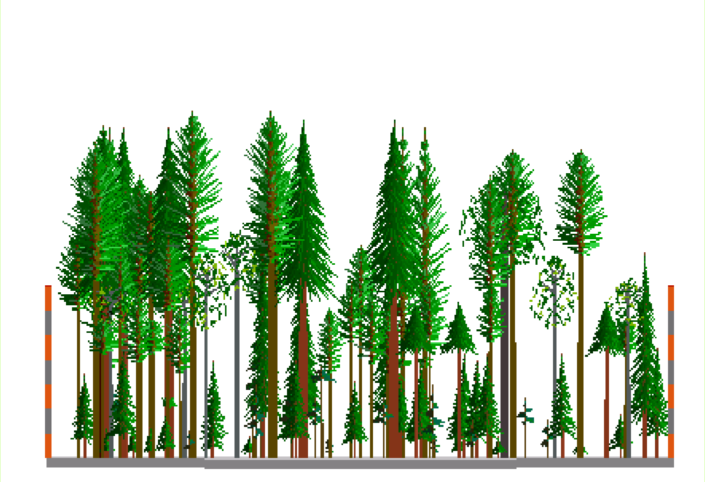
Management Options

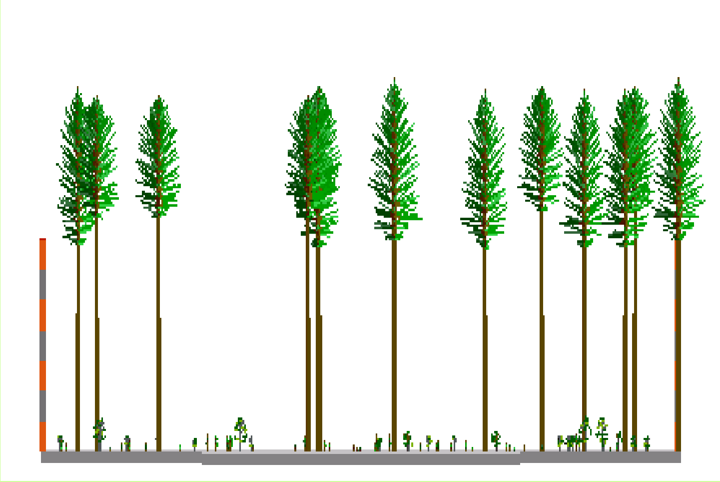


Managing fuels can be challenging!

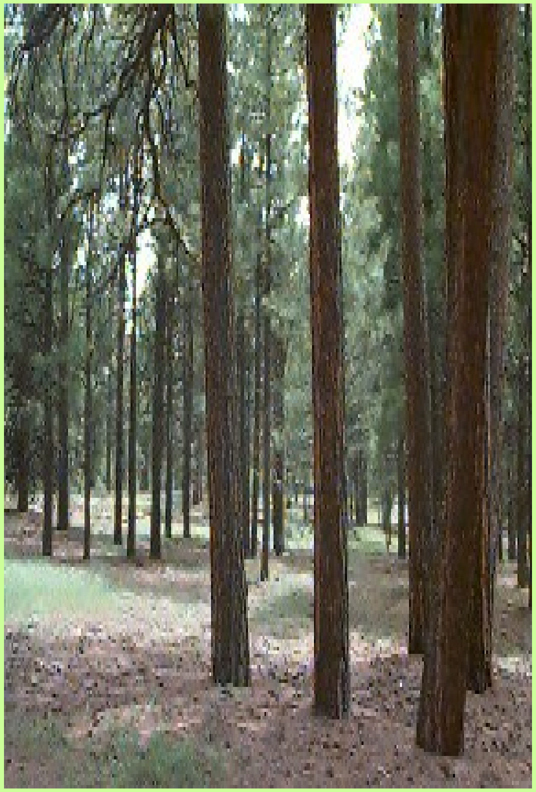
Current conditions

Target conditions





Thinning



Surface fuel treatment

Modifying forest structure and fuels: *A no-regrets management strategy*

Modify potential fire behavior

Reduce crown fire hazard

Increase resilience to increased fire frequency

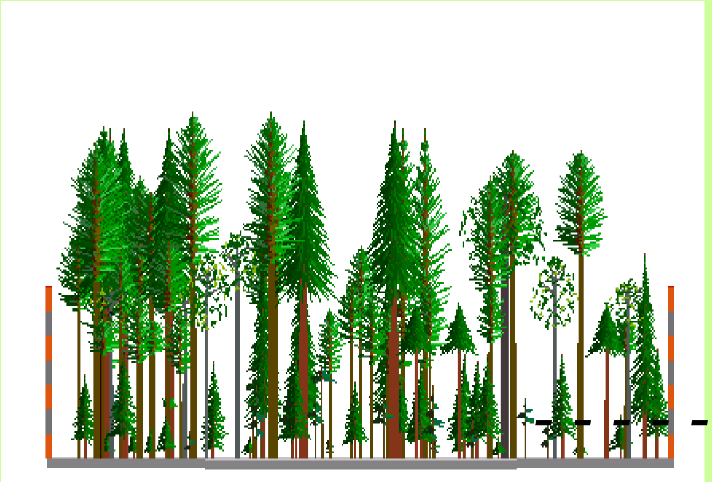
Increase resistance to insect attack

Silviculture meets fire science

- Increase *canopy base height*
- Reduce *canopy bulk density*
- Reduce *canopy continuity*

AND reduce *surface fuels*

Increase canopy base height



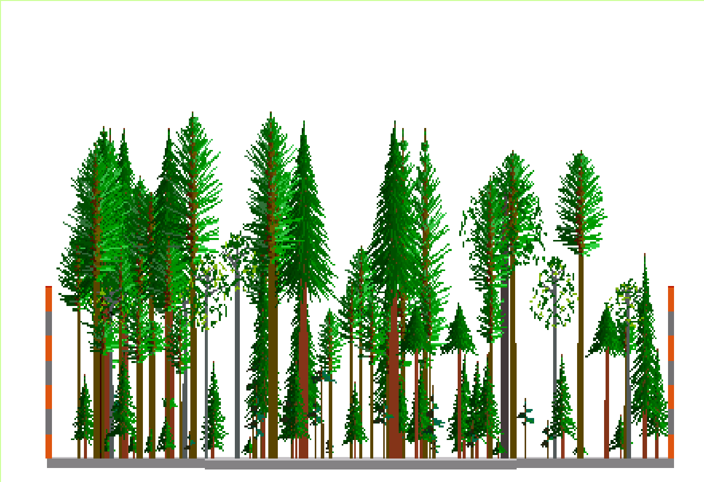
Dense stand with understory

Canopy base height < 2 m

Canopy base height > 6 m

Treated stand after thinning from below

Reduce canopy bulk density



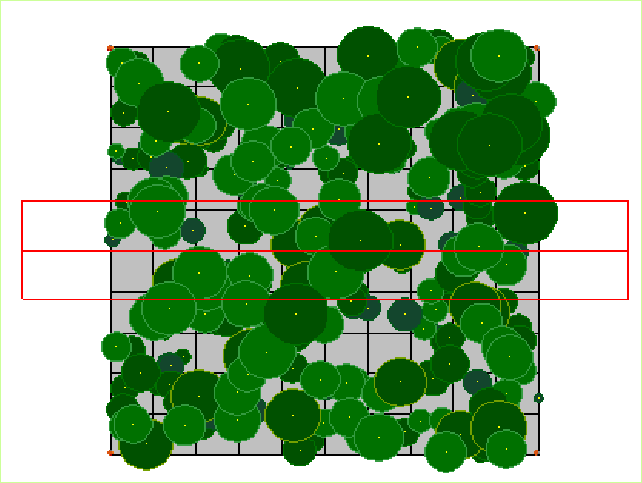
Dense stand with understory

Canopy BD > 0.30 kg m^{-3}

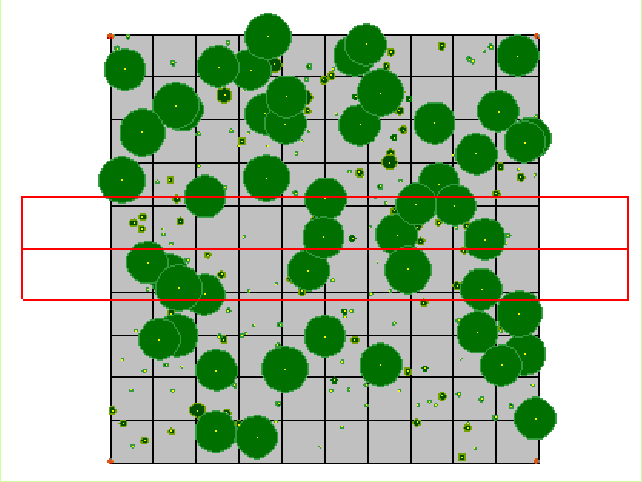
Canopy BD < 0.10 kg m^{-3}

Treated stand after thinning from below

Reduce canopy continuity



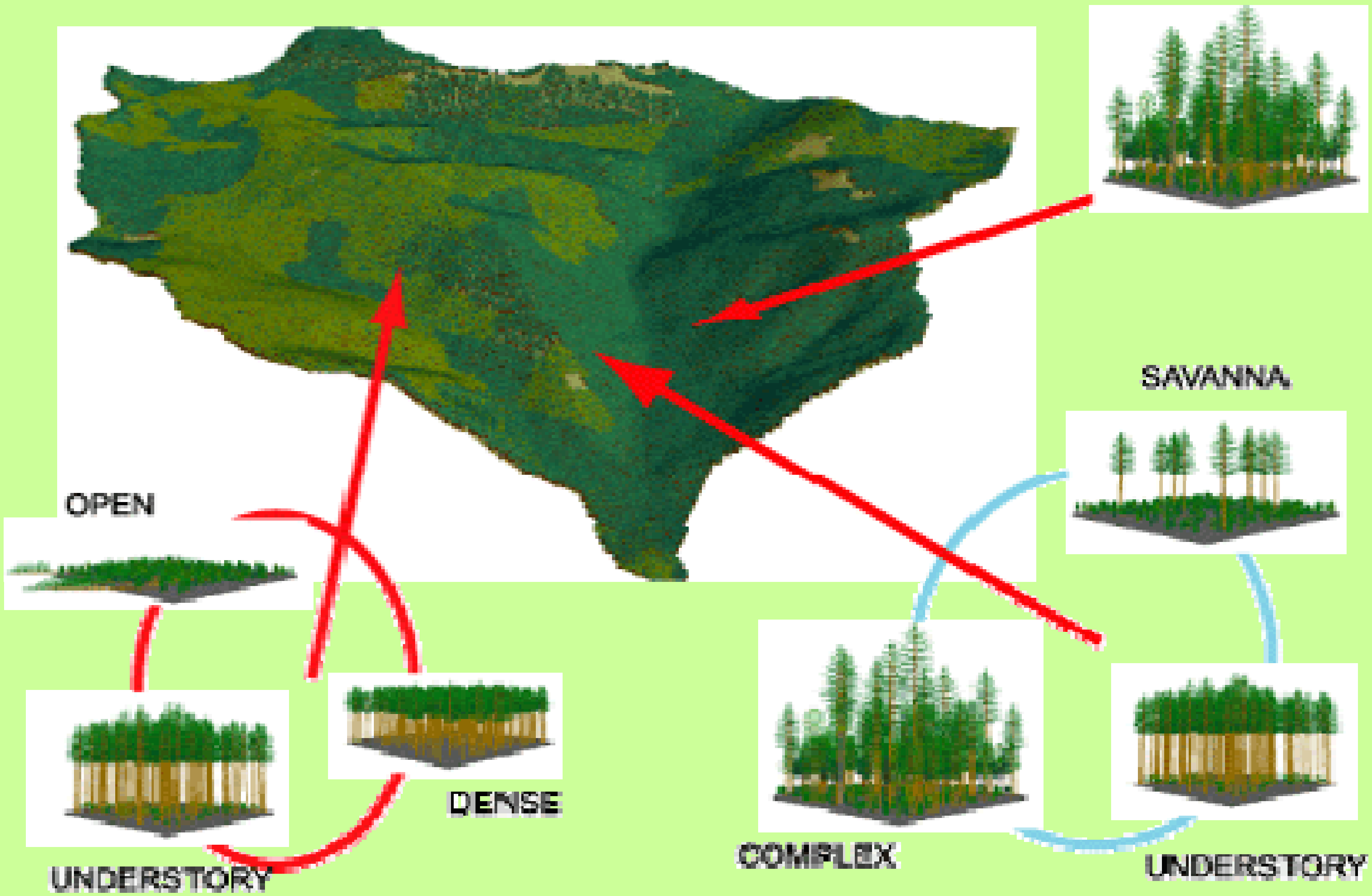
Dense stand with understory



Treated stand after thinning from below

Surface fuels must be treated following removal of trees

Effective fuel treatment programs must consider large landscapes



An example…

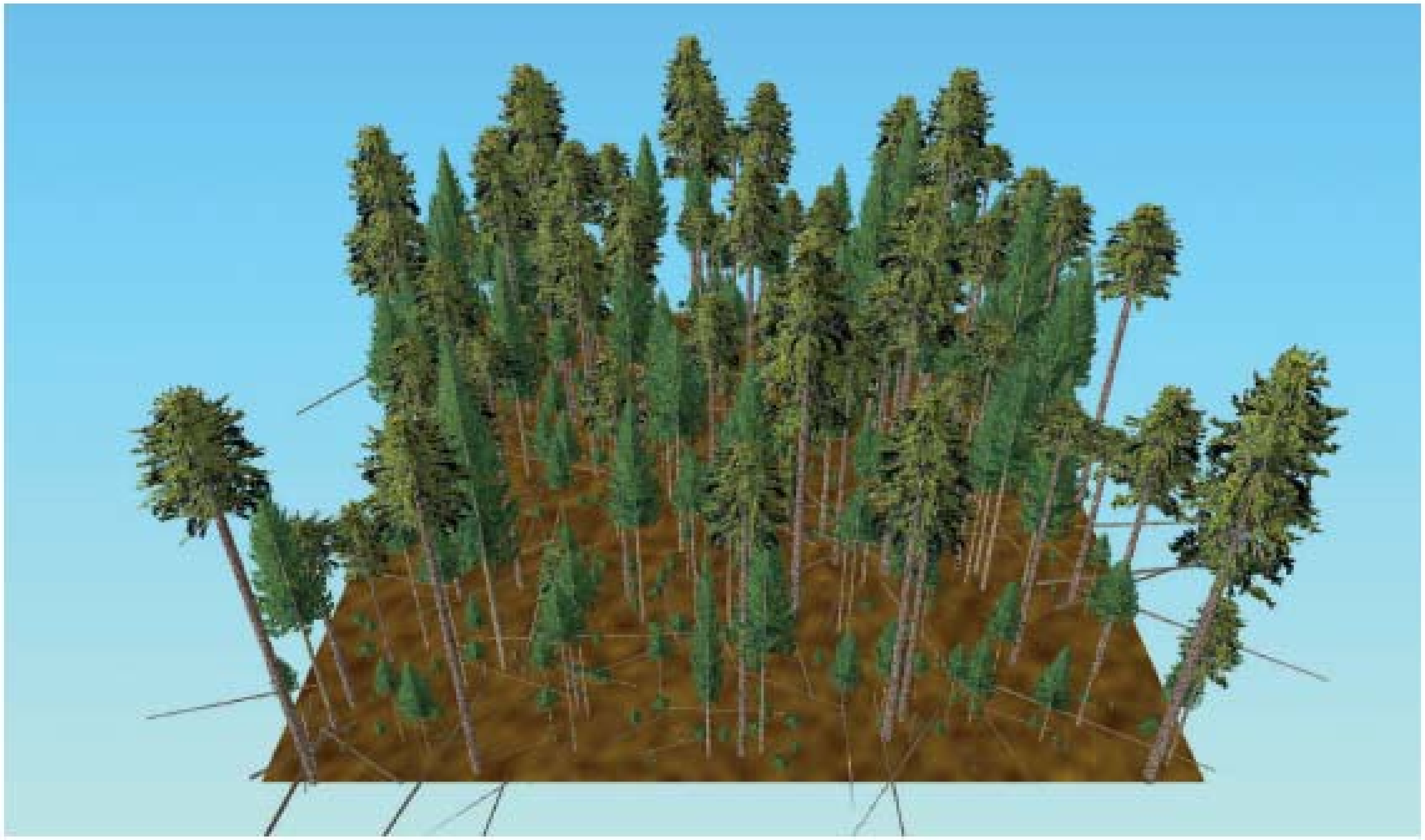
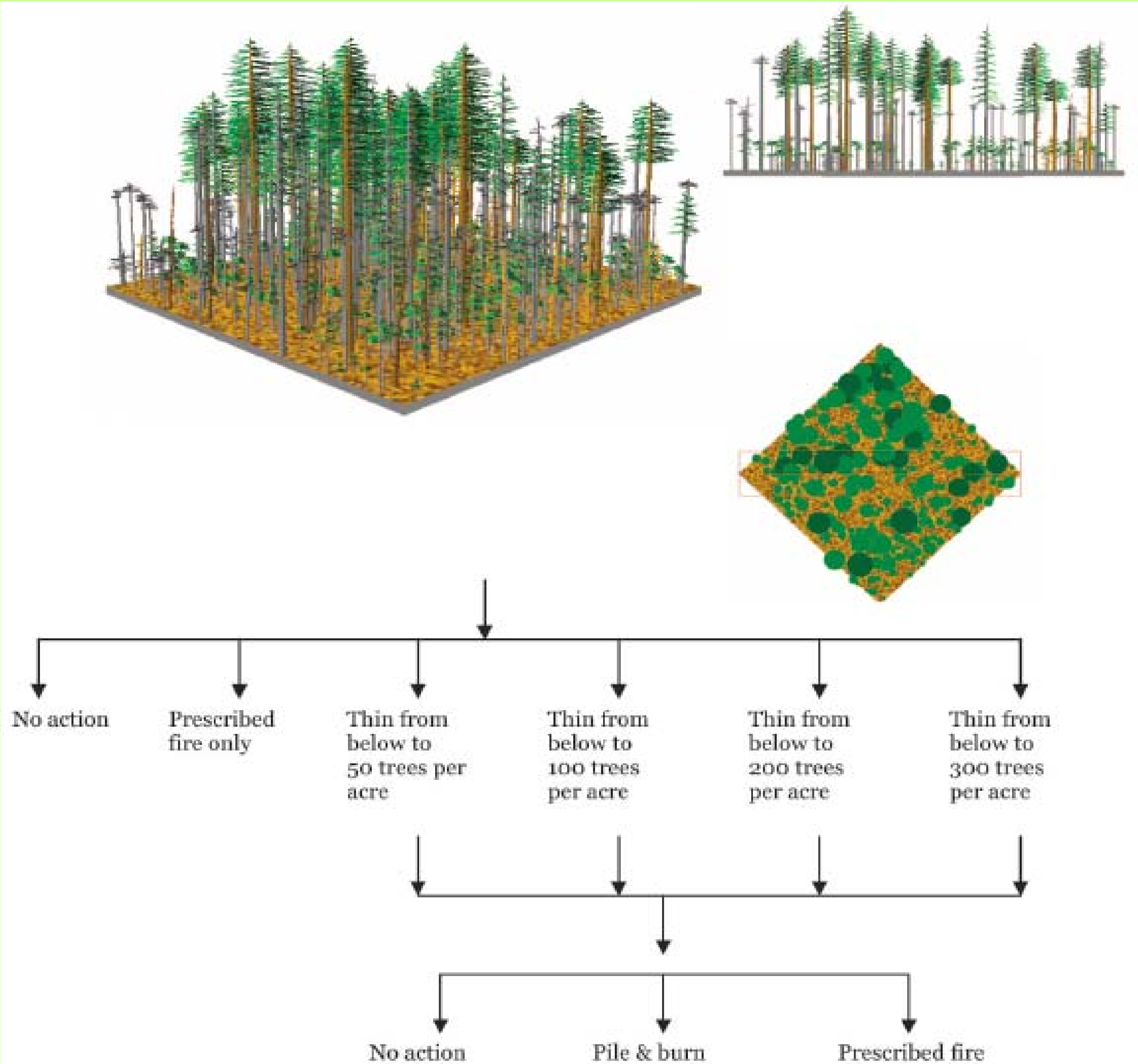


Figure 3. Initial stand conditions for a mixed conifer stand with ponderosa pine overstory on the Deschutes National Forest, Oregon. Stand structure and fuel attributes include quadratic mean diameter = 7.0 in., density = 947 tpa, basal area = 252 ft^2/ac, canopy cover = 62%, canopy base height = 3 ft, canopy bulk density = 0.13 kg/m^3, surface fuels less than 3 in. = 5 tn/ac, total surface fuels = 17 tn/ac. Different crown shapes represent different tree species.


No action
Prescribed fire only
Thin from below to 50 trees per acre
Thin from below to 100 trees per acre
Thin from below to 200 trees per acre
Thin from below to 300 trees per acre
No action
Pile & burn
Prescribed fire

The only treatment that minimizes crown fire

50-100 trees per acre

+ removal of surface fuels

Principles of fire resistant/resilient forests

Principle	Effect	Advantage
Reduce surface fuels	Reduces flame length	Control easier; less torching
Increase canopy base height	Requires longer flame length to begin torching	Less torching
Decrease crown density	Makes tree-to-tree crown fire less probable	Reduces crown fire potential
Keep big trees of resistant species	Less mortality for same fire intensity	Generally creates open structure with high crowns

Adapted from Agee and Skinner (2005)

A rational approach: Focus on the wildland-urban inerface

Benefits

Focus fuel treatment area

Protect high economic value

Reduce fire suppression cost

Respond to political concern

Create defensible zones

Reduce liability

Thank you!

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http://www.fs.fed.us/pnw/fera